NEW SHIPPING CONTAINERS FOR CUT ROSES—

COSTS AND PERFORMANCE

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NEW SHIPPING CONTAINERS FOR CUT ROSES— COSTS AND PERFORMANCE

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By Roger E. Rij, agricultural marketing specialist, and Robert Tom Hinsch, agricultural economist, Transportation and Facilities Research Division, Agricultural Research Service

SUMMARY

California cut roses can be packed and shipped in fiberboard hampers and in flat polystyrene-foam boxes at less cost than in conventionally used flat fiberboard boxes. The costs of packaging materials, coolant, storage, direct packing labor, and trucking and air transport charges from Oakland, Calif., to seven U.S. eastern and midwestern markets, for 500 cut roses packed in the flat fiberboard box were \$15.07. These costs were \$13.31 for the flat polystyrene-foam box and \$10.64 for the fiberboard hamper.

If the California cut roses that are normally shipped by airfreight—about three-fourths of total sales—were packed and shipped in fiberboard hampers instead of in flat fiberboard boxes, about \$1,000,000 could be saved annually. About \$400,000 could be saved annually if the cut roses were packed in the flat polystyrene-foam boxes instead of in flat fiberboard boxes.

The fiberboard hampers and the flat polystyrene boxes are more easily damaged than the flat fiberboard boxes, but the roses packed in each of the three shipping containers were practically undamaged on arrival at eastern and midwestern receivers.

In commercial-airfreight test shipments, the hampers containing 2 pounds of gel ice did not cool the roses as well as the conventionally used flat boxes containing 15 pounds of water ice or the polystyrene-foam boxes containing 7 pounds of water ice. In experimental high-temperature test shipments, the fiberboard hamper containing 5 pounds of dry ice or 5 pounds of water ice did not cool the roses as well as the flat fiberboard box containing 15 pounds of water ice and 2 pounds of gel ice, which is customarily used in the summer months.

INTRODUCTION

California is the largest producer of cut roses, with about 40 percent of the total production in the United States. Approximately 156 million cut rose blooms, with a wholesale value of \$14.5 million, were shipped from California in 1969.[1] About three-fourths of the total sales of roses from California are shipped out of State by airfreight.

The cost of packing and shipping cut roses to market is increasing for the California floral industry. Packing-labor and packaging-material costs have increased approximately 30 percent since 1965. Transport costs represent from 18 to 26 percent of the wholesale cost of cut roses. However, the price received for cut roses increased by only 9 percent between 1965 and 1969.[2]

The industry currently uses a flat fiberboard box for shipping cut roses. This box requires insulation material, crushed ice, wooden cleats, and nails, which increase the packing-labor cost. They also increase the weight of the box, which adds to the cost of transportation. In addition, the nails used to secure the wooden cleats in this box frequently become loosened and interfere with airline equipment and cause injury to personnel handling the boxes during marketing.

With the cooperation of the floral industry, research was undertaken to evaluate two new shipping containers that were designed to use less ice, reduce packing-labor requirements, and reduce the tare weight of the containers and accessory packaging materials. One, a flat polystyrene-foam box, was developed by a manufacturer of expanded polystyrene-foam products. Polystyrene foam has excellent insulation properties, is lightweight, and needs no accessory insulation materials. The other, a fiberboard hamper was developed by a flower shipper and a corrugated-container manufacturer. Less coolant and insulation material was used in it because the hamper was designed to be shipped in

[1] U.S. Department of Agriculture Flowers and foliage plants—Production and sales, 1968-69—Intentions for 1970 in selected States. Crop Reporting Board, SP CR 6-1 (70), April 1970.

[2] U.S. Department of Agriculture Marketing California Ornamental Crops 1969 Season. Federal-State Market News Service, January 1971, 44 pp., San Francisco, Calif.

an upright position, with the coolant next to the blooms rather than on the stems as is done in the flat boxes. Also the hamper required less labor to pack and had less tare weight than the currently used flat fiberboard box. In addition, the flat polystyrene-foam box and the fiberboard hamper did not require the use of wooden cleats and nails.

The purpose of this study was to compare the new box and hamper with the conventionally used flat fiberboard box with respect to their (1) effect on the cost of marketing cut roses, (2) performance in protecting the roses, and (3) suitability for handling during marketing.

COMMERCIAL AIRFREIGHT TEST SHIPMENTS

Procedure

Description of Containers.—The conventionally used flat fiberboard box was a 275-pound-test single-wall corrugated-design style box with cover (fig. 1, A and table 1). The interior of the box was lined with macerated paper enclosed in 40-pound kraft paper, a polyethylene sheet, and embossed plies of kraft paper used to absorb moisture.

Table 1.—Net weight of roses, tare weight, gross weight, outside dimensions, and volume of flat fiberboard box, flat polystyrene box, and hamper fiberboard box, 1969-1970

Item	Flat fiberboard box, water ice	Flat polystyrene box, water ice	Hamper fiberboard box, gel ice
	Pounds	*Pounds*	*Pounds*
Net weight of roses	28.0	28.0	28.0
Tare weight:			
Body and cover	6.5	4.0	5.2
Packaging materials	[1] 5.7	[2] .5	[3] 1.0
Coolant	15.0	7.0	2.0
Gross weight	55.2	39.5	36.2
	Inches	*Inches*	*Inches*
Outside dimensions	40½ x 21-¾ x 12-¾	40½ x 20½ x 15½	18 x 17-¾ x 29
	Cubic Inches	*Cubic Inches*	*Cubic Inches*
Volume	11,231.2	12,868.9	9,265.5

[1] Includes an insulated lining material of macerated paper, polyethylene sheet, embossed plies of kraft paper, five wood cleats, ten nails, and twine. [2] Includes three rigid polyvinyl chloride plastic tube cleats, twine, and eight fiberboard edge-protectors. [3] Includes three fiberboard dividers and polyethylene bag.

Five hundred cut roses, in bunches of 25, were packed horizontally with the blooms toward the ends of the box. They were held in place with five nailed wooden cleats. Fifteen pounds of crushed water ice, which is an average amount of coolant used commercially, was placed in the center of the box. The box was closed and tied with twine.

The experimental flat polystyrene-foam box tested was molded in two parts, body and cover, with a density of 1.50 pounds of foam per cubic foot (fig. 1, B and table 1). The cover fitted over a 5/8-inch high necked-in flange molded in the main body of the container. Lining materials were not used.

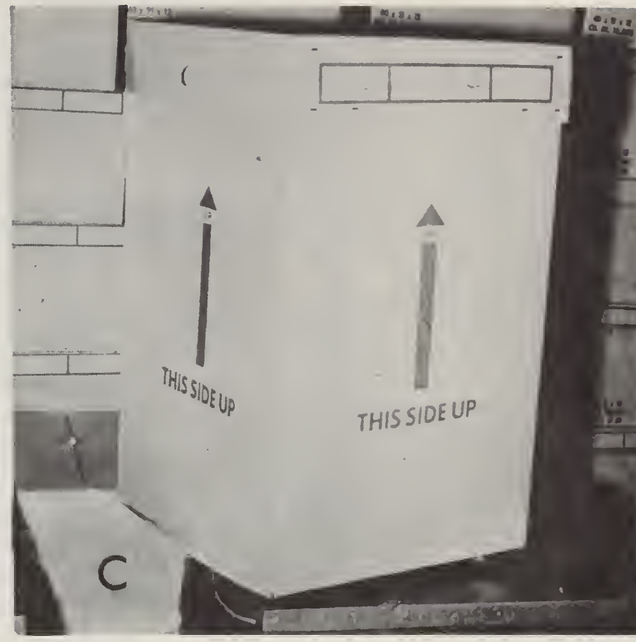
Five hundred roses were packed in the flat polystyrene-foam box in the same way as they were in the flat fiberboard box. Three rigid polyvinyl-chloride tube-cleats were used to hold the roses in place. The tube-cleats were slightly longer than the inside width of the flat polystyrene-foam box so that they penetrated the side walls of the box after they were in place. Seven pounds of crushed water ice was placed in the center of the box. This is approximately half the amount of coolant normally packed in the conventional container under commercial conditions. The high insulation ability of the polystyrene foam made it possible to reduce the amount of water ice used. The cover of the box was held in place by tying two pieces of twine around the box near each end of it. Eight fiberboard edge-protectors were used to prevent the twine from cutting into the body and cover of the box.

The experimental fiberboard hamper tested consisted of three parts—an interior 175-pound-test single-wall corrugated regular slotted container (fig. 1, D), an exterior 200-pound-test single-wall corrugated half-slotted container with self-locking bottom (fig. 1, C), and a design-style roll-side cover (see part telescope cover at top of hamper in fig. 1, C). Both the interior and exterior of this hamper had taped manufacturer's joints.

Accessory packaging materials included a polyethylene bag, three fiberboard dividers, and one sheet of white lining paper.

Five hundred roses were packed in the inner hamper with the blooms all facing one end in a horizontal position. Fiberboard dividers were placed between each layer of five bunches. Cleats were not used to hold the flowers in place. A nonperforated polyethylene bag was placed inside the exterior hamper. The inner container was inserted into the polyethylene bag in the exterior hamper. The exterior hamper was then set upright for shipment so the blooms were in a vertical position standing on their stems. The hamper was closed, and the cover was held in place with staples.

A—Flat fiberboard box



C—Fiberboard exterior hamper

B—Flat polystyrene box

D—Fiberboard inner hamper

Figure 1

The fiberboard hamper tested under commercial conditions included two pounds of gel ice placed on top of the inner container. Gel ice[3] was used instead of crushed water ice to protect the inner container from excessive moisture.

Cost Evaluation.—Packaging-material costs were obtained from manufacturers and suppliers. All packaging-material costs are based on price per thousand units for carlot orders.

A value of $1.25 per square foot per year was used as the amortized cost of a one-story dry-storage facility to compute the storage costs for the empty shipping containers at the floral shippers house. Fifteen days were used as the length of storage.

Direct labor costs for packing the containers were obtained by making time studies in a California floral shipper's house. A $2.00-per-hour wage rate was used to calculate packing-labor costs. Costs of crushed ice and gel ice were obtained from records of the cooperating floral shipper.

Trucking and air transport charges to seven major U.S. flower markets were determined from shipper's records, air freight forwarders, and published airfreight tariffs.

Costs of equipment, receiving, supervision, sales, insurance, and overhead were not included in this study, as they did not affect the choice of a container.

Performance Evaluation.—Six airfreight test shipments of cut roses were made from Oakland, Calif., to midwestern and eastern markets during the winter season to compare the performance of the three shipping containers. One box of each of the three containers was included in each experimental test shipment. Wholesale receivers of flowers normally do not buy more than three boxes of roses at one time.

Flower damage evaluation was based on the condition of the cut roses packed in the flat fiberboard boxes, in fiberboard hampers and in flat polystyrene boxes on arrival at the midwestern and eastern markets. Flower damage was recorded in two categories, bloom bruising and stem breakage. There were no other measurable differences in the appearance or condition of the flowers in the experimental commercial tests, other than bloom discoloration that may have been caused by CO_2 injury, which was tested in subsequent noncommercial test shipments. It was not possible to withhold the roses from sale long enough for other differences to appear without the receiver's risking the possible loss of sale of the flowers.

Container damage was determined by visual inspection on arrival of the test shipments. It was recorded in two categories—"slight" (usability of the box not affected) and "serious" (usability or reusability of the box affected).

[3] Gel ice—98 percent water, the remainder being carboxymethyl cellulose, aluminum sulfate, and a preservative to retard bacterial formation, enclosed in a leakproof plastic bag.

A recording thermometer was placed in each shipping container to obtain internal temperatures during transit. A recording thermometer was also attached to the outside of the flat fiberboard box to measure outside air temperatures during transit.

The suitability for handling the three types of boxes was determined by observing loading, unloading, and handling operations and by interviewing wholesale receivers.

Costs and Charges

Packaging Materials and Coolants.—The costs of packaging materials and the coolant were $1.61 for the flat fiberboard box, $3.28 for the flat polystyrene box, and $1.46 for the fiberboard hamper (table 2). Both of the experimental containers cost considerably more than the conventionally used flat fiberboard box, but the cost of accessory materials was much less. Coolant costs were higher for the fiberboard hamper.

Table 2.—Costs of packaging materials, coolants, storage, and direct labor to pack 500 cut roses, by type of container, 1969-1970[1]

Item	Flat fiberboard box, water ice	Flat polystyrene box, water ice	Hamper fiberboard box, gel ice
	Dollars	*Dollars*	*Dollars*
Materials:			
Container	0.63	3.00	1.16
Interior packaging and closure materials	.90	.24	.12
Coolant	.08	.04	.18
Total materials cost	1.61	3.28	1.46
Storage[2]	[3]	.05	[3]
Direct labor to pack:			
Assemble box	.02	---	.03
Line box	.09	---	.02
Pack box	.18	.18	.05
Close box	.06	.06	.05
Total labor costs	.35	.24	.15
Total costs of materials, storage, and packing labor	1.96	3.57	1.61

[1] These are direct costs only and do not include items such as cost of supervision, overhead, insurance, sales, and equipment. Labor was calculated at $2.00/hr. [2] Based on a value of $1.25 per square foot per year as the amortized cost of a one-story dry-storage facility and 15 days as the length of storage. [3] The cost for storing empty flat fiberboard boxes and fiberboard hampers was $0.003.

Storage.—The cost to store the empty rose-shipping containers before they were packed was $0.003 for the

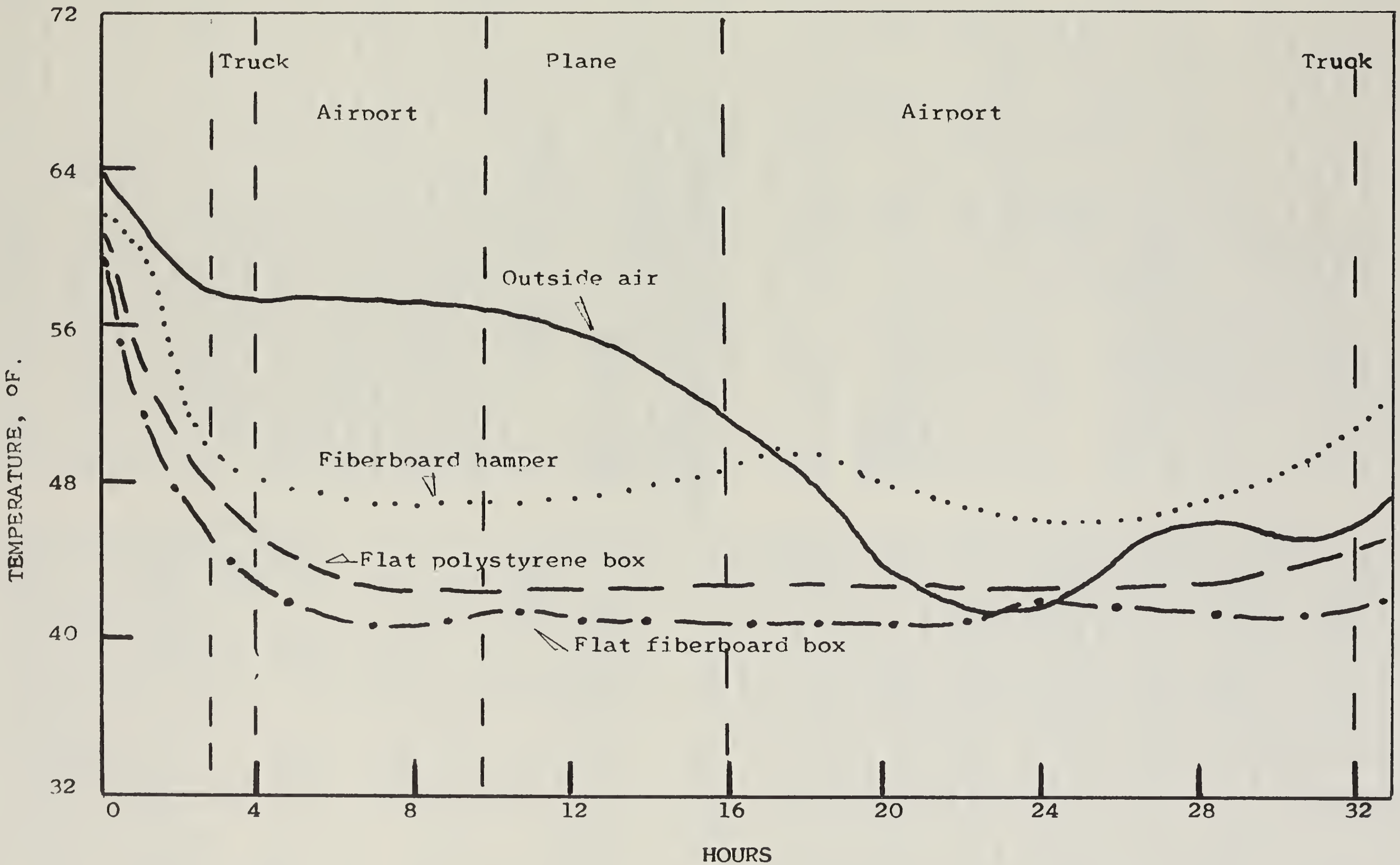


Figure 2.—Average transit temperature of cut roses packed in flat fiberboard and flat polystyrene boxes and fiberboard hampers in six test shipments, 1969-1970.

flat fiberboard box, $0.048 for the flat polystyrene box, and $0.003 for the fiberboard hamper (table 2). The flat polystyrene box, which was delivered premade, took up more storage room than the flat fiberboard box or the fiberboard hamper. This resulted in the higher storage cost.

Packing Labor.—The fiberboard hamper was the least expensive to pack, whereas the flat fiberboard box was the most expensive to pack. These direct labor costs to pack 500 cut roses were $0.35 for the flat fiberboard box, $0.24 for the flat polystyrene box, and $0.15 for the fiberboard hamper (table 2). Less labor was required to line the flat polystyrene box and fiberboard hamper with insulation material than the flat fiberboard box. The flat polystyrene box did not require labor to assemble it. The hamper fiberboard box required less labor to pack because wooden cleats and nails were not used.

Transport Charges.—Trucking and air transport charges, based on average freight rates from the Oakland, Calif., wholesale florist shipper to receivers in seven United States markets, were highest for the flat fiberboard boxes and lowest for the fiberboard hampers. These costs for 500 cut roses packed and shipped in flat fiberboard boxes were $13.11. They were $9.74 for the flat polystyrene boxes and $9.03 for the fiberboard hampers (table 3). The lower cost for the flat polystyrene box and for the fiberboard hamper was due to the lighter weight of the containers, interior packaging materials, and coolant.

Table 3.—Trucking and air transport charges for 500 cut roses, by type of container, from Oakland, Calif. to seven major U.S. markets, 1969-1970

Item	Flat fiberboard box, water ice	Flat polystyrene box, water ice	Hamper fiberboard box, gel ice
	Dollars	*Dollars*	*Dollars*
Transport charges:			
Wholesale house to airport[1]	1.25	1.25	1.25
Airport to airport[2]	10.86	7.77	7.12
Airport to receiver[3]	1.00	.72	.66
Total transport cost per box	13.11	9.74	9.03

[1] Cost based on per-box charge of $1.25 in San Francisco Bay area. [2] Air transport charges based on average freight rate of $19.68 per 100 pounds (from San Francisco, Calif., to: Atlanta, Ga., $23.05; Chicago, Ill., $16.25; Dallas, Tex., $17.10; Minneapolis, Minn., $18.60; New York, N. Y., $22.15; Pittsburgh, Penn., $19.55; and Washington, D.C., $21.10). [3] Airport-to-receiver charges based on an average trucking rate of $1.82 per 100 pounds (in Atlanta, Ga., $1.00; Chicago, Ill., $1.60; Dallas, Tex., $1.00; Minneapolis, Minn., $1.20; New York, N.Y., $2.55; Pittsburgh, Penn., $1.55; and Washington, D.C., $3.87).

Total Costs and Charges.—It costs more to market cut roses in the flat fiberboard box than in either the flat polystyrene box or in the fiberboard hamper. The costs of packaging materials, coolants, storage, packing labor, and average transport charges from Oakland, Calif., to seven major United States markets for 500 cut roses were $15.07 for the flat fiberboard box, $13.31 for the flat polystyrene box, and $10.64 for the fiberboard hamper (table 4).

Table 4.—Costs of packaging materials, coolant, storage, labor, and transport for 500 cut roses by type of container, 1969-1970

Item	Flat fiberboard box, water ice	Flat polystyrene box, water ice	Hamper fiberboard box, gel ice
	Dollars	*Dollars*	*Dollars*
Packaging materials, coolant, and storage	1.61	3.33	1.46
Packing labor	.35	.24	.15
Transport	13.11	9.74	9.03
Total cost per box	15.07	13.31	10.64

Lower packing-labor costs and reduced tare weight, which resulted in lower transport costs, were the principal factors accounting for the lower costs of marketing cut roses in flat polystyrene boxes and in fiberboard hampers than for marketing them in flat fiberboard boxes.

Performance of Containers

Protection from Mechanical Damage.—The roses packed in the three containers were practically undamaged on arrival at eastern and midwestern markets. In six airfreight shipments, none of the roses in the flat fiberboard box had bruised blooms or broken stems. The roses packed in the flat polystyrene box arrived with 1.0 percent of the blooms bruised and 0.04 percent of the stems broken. The roses packed in the fiberboard hamper arrived without any bruised blooms, but 0.08 percent of the stems were broken.

Protection from Temperature Extremes.—The average temperature of the roses after they were packed in the shipping containers for the six test shipments was 62° F. The roses in the flat fiberboard box and the flat polystyrene box cooled from about 62° to about 41° and 43°, respectively, 6 hours after they were packed; but the roses in the fiberboard hamper cooled to only 47° (fig. 2). The flat fiberboard and the flat polystyrene boxes maintained relatively constant temperatures around 41° and 43°, respectively, until they arrived at eastern and midwestern

receivers—approximately 33 hours after packing—but the temperatures in the fiberboard hamper fluctuated around 48°. An average of 4 pounds of crushed water ice remained in the flat fiberboard boxes, and approximately one pound of crushed water ice remained in the flat polystyrene boxes on arrival at the receivers. The gel ice in the fiberboard hampers was usually thawed.

Suitability for Handling and Receiving.—Three of the six commercially test-shipped flat fiberboard boxes arrived slightly damaged (usability not affected) at the wholesale receiver. None of the boxes were seriously damaged (usability affected). The slightly damaged boxes had creases or scuffs, which did not affect the performance of the container (fig. 3).

Three of the six commercially test-shipped flat polystyrene boxes were slightly damaged, and one was seriously damaged, on arrival at the wholesale receivers. The slightly damaged boxes had cracks and chips in the body and cover, which did not affect the container's performance. The seriously damaged box had a broken cover and broken sides and could not be reused (fig. 3). The damage to the boxes was caused by rough or improper handling.

One of the six fiberboard hampers that were commercially test-shipped was slightly damaged, and two were seriously damaged upon arrival at the wholesale receivers. The slightly damaged hamper had creases and scuffs. The seriously damaged hampers had the cover missing, or the sides and bottom were split, which adversely affected the containers' usability (fig. 3).

The floral wholesaler receivers liked flat polystyrene boxes and fiberboard hampers because wooden cleats and nails were not used. This eliminated that danger of injury to employees who were unpacking the boxes.

The handlers liked the light weight of the flat polystyrene box, but they were concerned about its fragility. Also, the wholesale receivers felt that there might be a problem of disposing of this container after it was unpacked.

The fiberboard hamper had hand holes near the top of the box. This made it more likely to be handled carefully and less likely to be "thrown" than the flat boxes. The hamper was easy to lift and to load and unload from transport vehicles because the handlers did not have to bend over to grasp it as they did with the flat fiberboard box and the flat polystyrene box. Also, because water ice was not used as a coolant, the interior of the hampers remained dry. Wholesale receivers stated that unpacking the fiberboard hamper was more difficult than unpacking either the flat fiberboard box or the flat polystyrene box. Pulling the interior container out of the exterior part of the hamper was awkard.

NONCOMMERCIAL HIGH-TEMPERATURE TEST SHIPMENTS[4]

Procedure

Although the six commercial test shipments provided adequate data on the performance of the polystyrene-foam box, further tests of the fiberboard hamper seemed desirable for two reasons: (1) The average transit temperature of the roses in the hamper was 6° F. higher than that in the control box, which might prove to be a serious deficiency in hot weather, and (2) researchers who evaluated the arrival condition of the six commercial test shipments thought there was some evidence of "smothering" or bloom discoloration of the roses in the hampers. This appearance could have been caused by excessive buildup of carbon dioxide and depletion of oxygen within the hamper, coupled with the higher temperatures.

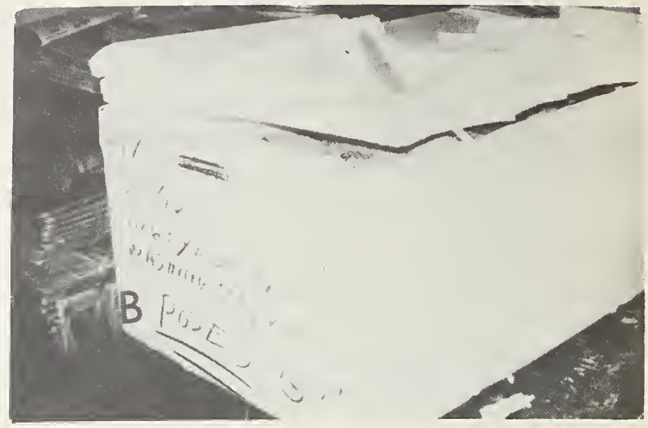
Four high-temperature noncommercial test shipments were made from Oakland to Fresno, Calif. by automobile during the summer of 1970 for further evaluation of the hamper with respect to its ability to provide a suitable temperature and atmosphere environment for the roses during hot weather. Each of the four test shipment contained: (1) one fiberboard hamper with 5 pounds of solidified carbon dioxide (dry ice) placed on top of the inner container and on top of the closed polyethylene bag. The bag was perforated with 36 1/4-inch holes; (2) one fiberboard hamper with a 5-pound block of water ice enclosed in a leakproof polyethylene bag, which was also placed on top of the inner container. The bottom of the exterior hamper was lined with a polyethylene sheet to collect moisture from the melting 5-pound block of ice; and (3) a control box—the flat fiberboard box with 15 pounds of water ice and two pounds of gel ice, which is customarily used in hot weather.

Each of the three boxes were packed with 500 roses of comparable quality and condition. The temperature of the roses at time of packing was 48° F. After the roses were packed, they were transported to Fresno by automobile and placed in the laboratory at room temperature to simulate a 24-hour commercial transit period. A potentiometer with multiple thermocouple leads was used to record the ambient temperature and temperature of the roses in each of the three boxes from the time they were packed until the end of the 24-hour period. The ambient temperature during the 6-hour ride in the automobile varied from 72° to 86°, and the room temperature in the laboratory for the remaining 18 hours varied from 76° F. to 78°.

After the 24-hour simulated in-transit period, the amount of carbon dioxide (CO_2) and oxygen (O_2) in

[4]This part of the study was done in cooperation with Dr. Masami Uota, Principal Horticulturalist, Market Quality Research Division, Agricultural Research Service, Fresno, Calif.

A—Slightly damaged flat fiberboard box on arrival at market.



B—Seriously damaged flat polystyrene box on arrival at market.

C—Seriously damaged fiberboard hamper on arrival at market.

Figure 3

each box was determined by using a Burrell Gas Analysis Apparatus.[5] Then the roses were removed from the boxes and placed in cans of water at 35° F. for 18 more hours to simulate a wholesale florist's holding period. After that, they were held at 80° for 8 hours to simulate the time required to deliver and display them in a retail florist's shop.

Following the 50-hour simulated in-transit and holding period, a sample 100 roses from each of the three boses were selected and observed for damage to the flowers and for degree of bloom opening. Bloom opening was recorded in five categories: Unopened, very slightly open, slightly open, mostly open, and completely open.

An analysis of variance was used to determine the statistical significance of the amount of carbon dioxide and oxygen in the containers and its effect on the opening of the blooms.

Protection from Temperature Extremes and Atmosphere Modification

The flowers packed in the flat fiberboard box containing 15 pounds of crushed water ice and two pounds of gel ice stayed cooler longer than the flowers in either the fiberboard hamper with a 5-pound block of dry ice or the fiberboard hamper with a 5-pound block of water ice in the four noncommercial high-temperature test shipments (fig. 4). Twenty-four hours after packing, with ambient temperatures ranging from 72° F. to 86°, the temperature of the roses was 68° in the flat fiberboard box, and two pounds of crushed water ice and one pound of gel ice remained. The temperature of the roses in the fiberboard hamper that was packed with a five-pound block of dry ice was 80°, compared with 84° in the fiberboard hamper packed with a five-pound block of water ice. The dry ice had completely dissipated, and the water ice had completely melted. Although the dry ice kept the roses cooler longer than the water ice in the fiberboard hamper, neither coolant in the fiberboard hampers cooled the roses as well as the conventionally used flat fiberboard box containing 15 pounds of water ice and two pounds of gel ice.

Twenty-four hours after packing, the fiberboard hamper box with dry ice had the highest buildup of carbon dioxide and the lowest amount of oxygen, and the flat fiberboard box with water ice had the least carbon dioxide buildup and the highest amount of oxygen. The average amount of carbon dioxide and oxygen in the flat fiberboard box and the two fiberboard hampers with dry ice and with water ice, 24 hours after packing, was as follows:

	Carbon Dioxide	Oxygen
	Percent	*Percent*
Flat fiberboard box	1.7	19.4
Fiberboard hamper with dry ice	11.7	10.3
Fiberboard hamper with water ice	6.6	14.4

Injury to the rose blooms caused by high carbon dioxide or low oxygen was not evident in any of the four noncommercial high-temperature test shipments. The difference in percentage of carbon dioxide between the flat fiberboard box, the fiberboard hamper with dry ice, and the fiberboard hamper with water ice was statistically significant. The difference in the percentage of oxygen between the flat fiberboard box and the fiberboard hamper with dry ice was statistically significant.

After the 26-hour conditioning period (50 hours after packing), 9 percent of the roses packed in the flat fiberboard box, 7 percent of the roses packed in the fiberboard hamper with dry ice, and 3 percent of the roses packed in the fiberboard hamper with water ice were unopened (table 5). The difference between the flat fiberboard box and the fiberboard hamper with water ice was statistically significant. This was probably caused by the lower temperatures maintained in the flat fiberboard box—68° F. after 24 hours compared with 80° and 84° for the fiberboard hampers with dry ice and with water ice, respectively, rather than caused by the differences in atmosphere within the boxes.

Table 5.—Percentage of cut roses opened in flat fiberboard boxes, fiberboard hampers with dry ice, and fiberboard hamper with water ice, by degree of bloom opening, four controlled shipments, Oakland, Calif. to the Fresno Field Station Laboratory, 1970[1]

Degree of bloom opening	Flat fiberboard box	Fiberboard hamper	
		Dry ice	Wet ice
	Percent	*Percent*	*Percent*
Unopened	9.50 a	7.00 ab	2.75 b
Very slightly open	27.75	29.50	20.25
Slightly open	32.00	29.75	28.00
Mostly open	21.25	24.75	35.00
Completely open	9.50	9.00	14.00
Total	100.00	100.00	100.00

[1] Percentages of unopened blooms, followed by different letters in the same row, are significantly different at the 5-percent level, based on Duncan's new multiple-range test.

[5] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

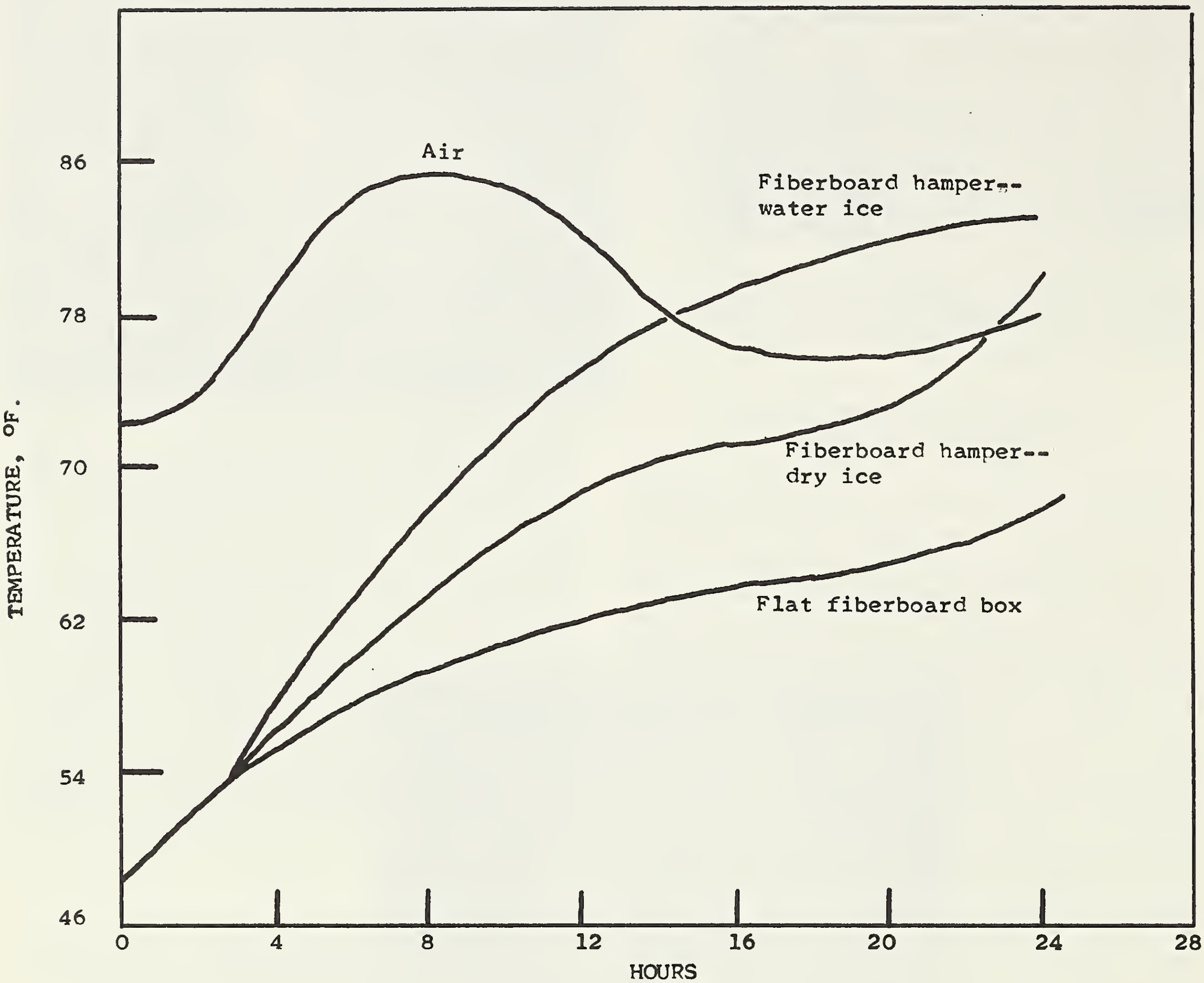


Figure 4.—Average temperature of cut roses packed in flat fiberboard box, fiberboard hamper with dry ice, and fiberboard hamper with water ice, under controlled conditions.

DISCUSSION AND RECOMMENDATION

Investigations of new shipping containers indicate that the cost of marketing cut roses can be reduced, and that the new shipping containers will deliver the roses without mechanical damage or bloom injury caused by excessive buildup of carbon dioxide and depletion of oxygen. However, perforated polyethylene bags rather than nonperforated bags should be used to avoid excessive buildup of carbon dioxide and depletion of oxygen.

The cost of packaging materials, coolant, storage, packing labor, and transport for packing and shipping cut roses in either a flat polystyrene box or in a fiberboard hamper was less than in the conventional flat fiberboard box. The calculated cost, per 500 cut roses, was $1.76 and $4.43 less when they were packed and shipped in the flat polystyrene box and in the fiberboard hamper, respectively, than when they were packed and shipped in the flat fiberboard box. Approximately 117 million California cut roses are airfreighted to market each year. About $400,000 could be saved annually if they were packed and shipped in the flat polystyrene boxes, and about $1,000,000 if they were packed in the fiberboard hampers.

Except for temperature maintenance and container damage, both of the new shipping containers performed adequately during marketing. The flat polystyrene box is more suitable than the fiberboard hampers for shipping cut roses during periods of very low or very high temperature because of its ability to insulate roses against temperature extremes. However, these boxes can be broken if they are not properly handled during transport and in the distribution channels. The fiberboard hamper is suitable for shipping roses when they will not be exposed to temperature extremes.

The flat fiberboard box with conventionally used insulation materials and coolants performed considerably better in maintaining desirable temperatures of the roses within the box than the fiberboard hamper and slightly better than the polystyrene-foam box under both cool and warm weather conditions. Five pounds of dry ice was a more effective coolant than 5 pounds of water ice in the fiberboard hamper under hot weather conditions. However, even through the dry ice in the fiberboard hamper was closer to the blooms, it did not keep the roses as cool as the 15 pounds of water ice and 2 pounds of gel ice used in the flat fiberboard box.

The feasibility of providing more insulation materials in the hamper to protect the roses from freezing during cold weather and of providing more refrigerant to reduce the temperature of the roses during hot weather could be further tested by the floral shippers.

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